Original Article

The Role of Radiofrequency Hyperthermia in The Radiosensitization of A Human Prostate Cancer Cell Line

Azam Janati Esfahani, Ph.D.[1], Seied Rabi Mahdavi, Ph.D.[2]*, Mohammad Bagher Shiran, Ph.D.[1], Samideh Khoei, Ph.D.[1]

1. Department of Medical Physics, Iran University of Medical Sciences, Tehran, Iran
2. Radiation Biology Research Center, Department of Medical Physics, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

*Corresponding Address: P.O.Box: 1449614535, Radiation Biology Research Center, Department of Medical Physics, School of Medicine, Iran University of Medical Sciences, Shahid Hemmat Highway, Tehran, Iran
Email: srmahdavi@hotmail.com*

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Abstract

Objective: This study evaluated enhanced induced DNA damages and apoptosis of a spheroid culture of DU145 prostate cancer cells treated by a combination of radiofrequency hyperthermia (RF HT) with radiation treatment (RT) from an external radiotherapy machine compared to RT alone.

Materials and Methods: In this experimental study, DU145 cells were cultured as spheroids until they reached 300 µm in diameter. We exposed these cultures to either: RF HT for 90 minutes at 43˚C originated from a Celsius TCS system, RF HT followed by RT at doses of 2 Gy or 4 Gy (15 MV energy) with 15-minute interval, or RT alone at the above mentioned doses. The trypan blue exclusion assay, alkaline comet assay, and annexin V/PI flow cytometry were performed to measure cell viability, the amount of DNA damage in an individual cell as the tail moment, and percentage of induced cell apoptosis in response to treatments explained.

Results: We calculated the thermal enhancement factor (TEF) for the combined treatment regime. RF HT followed by the 4 Gy dose of RT resulted in minimum viability (85.33 ± 1.30%), the highest tail moment (1.98 ± 0.18), and highest percentage of apoptotic cells (64.48 ± 3.40%) compared to the other treatments. The results of the TEF assay were 2.54 from the comet assay and 2.33 according to flow cytometry.

Conclusion: The present data suggest that combined treatment of mega voltage X-rays and RF HT can result in significant radiosensitization of prostate cancer cells.

Keywords: Radiation, Hyperthermia, DNA Damage, Apoptosis, Prostate Cancer

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Introduction

Radiofrequency (RF) capacitive heating, in combination with radiotherapy has been applied by several investigators as cancer treatment, including deep seated tumors (1-3). Because of the capacitive effects in the tissue, heat is generated (4). It is possible to efficiently heat deeper regions by the application of two electrodes in terms of size, output, and cooling temperature on both sides of the target area as a dielectric material. Hyperthermia (HT) is defined as a therapeutic procedure used to raise an entire body or local tissue temperature to about 42-45˚C (mild HT). Tumor cells most resistant to radiation, including oxygen- and nutrition-deprived cells at an acidic pH and in S-phase, are recognized as the most sensitive to HT (5, 6). However, the exact underlying mechanisms of HT have not been determined at the molecular level. It was found that HT in conjunction with radiation had a radiosensitizing effect. Combined HT with